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Missouri Drought Response Plan

by

Don E. Miller

and

Charles R. Hays

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PREFACE

The drought of 1988-89 cost the United States an estimated $39 billion dollars. To provide perspective, estimated damages of the record flood of 1993 were in the range of $12 to $16 billion. In considering this, one conclusion is inescapable— the social and economic costs of drought are substantial and cannot be ignored.

As a society, we continually fail to consider our response to drought until it is already upon us. Unfortunately, at this point it is too late for advance planning; the only options remaining are impromptu, which are adequate at best but seldom satisfactory. Given the extent to which we rely upon an acceptable water supply for our health and well being, the need for advanced drought planning is obvious. During the 1988-89 drought, water supplies for several municipalities were severely taxed, some to exhaustion. Other water users were forced to face severe economic losses. In every case, a drought plan, prepared in advance, could have substantially lessened the hardship for everyone affected.

This paper addresses the response component of drought planning. It defines basic linkages between local, state and federal jurisdictions for coordinated planning and response efforts. A greater awareness of the need for coordinated planning will lead to improved communication and make it possible for Missouri to provide better protection for the state's human, economic and natural resources.

David A. Shorr, Director
Missouri Department of Natural Resources

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INTRODUCTION

Drought planning is action taken by individual citizens, industry, government, and others in advance of water shortages to mitigate some of the impacts and conflicts associated with its occurrence.

The State Water Resources Plan (RSMo 640.415), which is a provision of the Water Resources Law enacted by the Missouri Legislature in 1989, requires the Department of Natural Resources (DNR) to ensure that the quality and quantity of Missouri's water resources are maintained at the highest possible level to support present and future beneficial uses.

The provision was established to provide for the development, maintenance and periodic updating of a long-range, comprehensive statewide plan for the use of surface and groundwater. It includes existing and future requirements for drinking water supplies, agriculture, industry, recreation, environmental protection and related needs.

The department is responsible for collecting data, making surveys, conducting investigations and providing recommendations concerning the social, economic and environmental water resources needs of the state.

Water quality and availability affects the well being of all Missouri citizens. When water quality is good and the supply is plentiful, the two critical factors—quality and quantity—are often taken for granted. But when good water becomes a scarce commodity and people must compete for the available supply, then the importance of these two factors increases dramatically. Quite often, only a few water users are critically affected but in cases of severe and prolonged drought, everyone may be affected.

The primary purpose of the *Missouri Drought Response Plan* is to address the need for coordinated advanced emergency planning. It complements and supports the State Consolidated Plan and the State Emergency Operations Plan. Oftentimes we are reactive when it comes to disaster response. The drought response plan outlines proactive emergency and tactical measures designed to better prepare us for drought. It is a drought response plan and does not eliminate the need for long range strategic planing, which would address the bigger issue of drought impact avoidance.

This plan is the result of Midwest drought data collection and evaluation work done by DNR's Division of Geology and Land Survey, Water Resources Program staff. Ideas were "brainstormed" over a period of several months to formulate a

drought plan that fits Missouri. It is modeled, in part, on the Kentucky Drought Response Plan.

During the preparation of this plan, input was solicited from various water management programs within the department, and from the Missouri departments of: Agriculture, Conservation, Economic Development, Health, and Public Safety.

The Missouri Department of Natural Resources gratefully acknowledges the support and assistance it has received. Don Miller was the primary compiler. Richard M. Gaffney assisted in reviewing the text for the Water Resources Program. Charles Hays coordinated the plan within DNR and was responsible for including agency comments. Steve McIntosh directed plan production and facilitated interagency review with state agencies.

PROBLEM

Drought, as it affects the citizens of Missouri, is primarily a problem of rural water supply. Large municipalities, with a few exceptions, have not had major water supply problems to the same degree that small communities have had. Small communities supplied by small surface water structures have experienced some serious difficulties.

Drought is basically a regional issue with statewide implications. Preventing water shortages in public water systems should be one of the major goals of drought mitigation. The design and construction of systems for the "drought of record" or some other reliable measure must be a significant part of any plan for drought response. State regulatory and funding agencies need to be involved at an early stage to do proper planning. Government and the public, particularly in northwest Missouri, have not taken advantage of all the lessons learned during the 1988-1989 drought.

Planning for drought should go beyond simply working to find sources of potable water and getting it to where it is most needed. Planning should also include assessment of the vulnerability of the activities or growth planned within the drought-prone areas. Facilities and activities that consume large amounts of water should not be located in areas that are vulnerable to extreme drought. Expansions of existing facilities should carry the same restrictions.

Another aspect of drought planning, not to be overlooked, is that drought can be a statewide, regional, or localized problem. The type of response needed will depend on the size of the affected area, as will the data needs and the resources which have been committed to solving the problem. Local drought response (Appendix 4) should be implemented at an early stage during any observed decrease in water availability. Implementation of regional

and statewide responses will occur as the effects of the drought expand in size.

Missouri presently has only five observation wells for monitoring groundwater levels in the most drought-prone areas of the state. Many of the state's smaller stream tributaries are ungaged. Recent evaluations on many of the small water-supply reservoirs exist, but much more work is needed to make this data base complete. In recent years, the continual loss of funding for gathering needed water supply information for some locations has created a paucity of information.

Water metering should be improved so that water loss can be detected. Distribution systems should be up-graded as much as is practicable (especially in drought-vulnerable areas) to eliminate water loss. Where water supply wells are used, the utility should keep accurate, monthly records of draw-down so that background information may be developed to allow for the timely assessment of drought conditions.

DEFINING DROUGHT

Initiation and execution of the *Missouri Drought Response Plan* relies upon an accurate assessment of existing drought conditions. A fundamental element of planning is the establishment of criteria which, if properly considered, can be used to gauge drought severity. In the following paragraphs, several drought severity indicators are briefly discussed. The information is not meant to serve as a direction for the use of drought indicators, but is intended to provide a basis for further inquiry regarding drought assessment procedures. Through refinement of these procedures, water management professionals will be able to recognize the onset of drought conditions and act appropriately.

The most commonly used drought severity indicators are the Palmer Drought Severity Index (PDSI), and the Crop Moisture Index. Each of these indicators are published jointly on a regular basis by the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Department of Agriculture (USDA).

The Palmer index is more widely used than any other single indicator; the Missouri Drought Response System joins a number of states in placing primary emphasis on the PDSI in determinations of drought severity. The PDSI provides a standardized means of depicting drought severity throughout the continental United States. It measures the departure of water supply (in terms of precipitation and stored soil moisture) from demand (the amount of water required to recharge soil and keep rivers, lakes and reservoirs at normal levels). By relating these figures to the previous regional index, a continuous "stream"

of data is created reflecting long-term wet or dry tendencies.

Missouri has six regions that display similar climatic characteristics. For each region, drought severity can be determined according to the following schedule:

Above	4.0	Extreme Moist Spell
3.0 to	3.9	Very Moist Spell
2.0 to	2.9	Unusual Moist Spell
1.0 to	1.9	Moist Spell
0.5 to	0.9	Incipient Moist Spell
0.4 to	-0.4	Near Normal Conditions
-0.5 to	-0.9	Incipient Drought
-1.0 to	-1.9	Mild Drought
-2.0 to	-2.9	Moderate Drought
-3.0 to	-3.9	Severe Drought
Below	-4.0	Extreme Drought

In addition to the NOAA/USDA-produced indicators, water management agencies in Missouri have access to the Missouri Crop and Weather Report, produced by the Missouri Agricultural Statistics Service. These reports provide detailed statistical information on weather conditions, crop conditions, topsoil moisture supply and subsoil moisture supply by subregion throughout Missouri.

Other indicators of drought severity less conceptual in nature than the Palmer Index do exist, however, they are typically used to support the conclusions of the Palmer Index. In a practical sense, they often serve as the de facto "triggers" of any drought response effort. These include: water demand versus supplies available, reductions in streamflow, declining reservoir levels, precipitation deficits, falling water levels in wells and soil moisture supply.

Current drought literature commonly distinguishes between three "categories" of drought, all of which define drought in simplified terms:

1. Agricultural drought, defined by soil moisture deficiencies

2. Hydrological drought, defined by declining surface and groundwater supplies

3. Meteorological drought, defined by precipitation deficiencies

For the purposes of drought response planning, all three categories can be regarded as equivalent, since each one relates the occurrence of drought to water shortfalls in some component of the hydrologic cycle. At first glance, this association appears to be self-evident; however, it serves to point out a potential pitfall in the use of drought indicators. *No single drought indicator can be reliably used to predict the onset of drought.* Regional indicators such as the Palmer Index are limited in that they respond slowly to deteriorating conditions (thus misrepresenting drought severity). They sometimes make unrealistic assumptions using insufficient data. On the other hand, surface and groundwater measurements are "snapshots" of local conditions and do not consider the full hydrologic cycle.

For example, if precipitation levels were to fall below normal for an extended period of time, the conditions for meteorological drought would be satisfied. However, a precipitation deficit does not necessarily mean there is a water-supply shortage. Someone approaching drought assessment from the hydrological or agricultural drought perspective might be only peripherally concerned by the lack of rain, and respond only when streamflow or soil

PALMER DROUGHT SEVERITY INDEX
Missouri Subregions

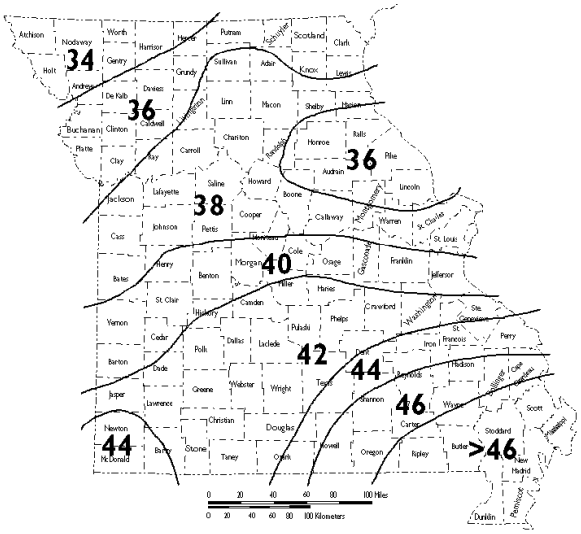
moisture levels have fallen significantly. Consequently, the use of a variety of drought indicators is essential to any effective assessment of drought conditions.

The Missouri Drought Response Plan relies primarily upon the Palmer Index to indicate drought severity, and supports its findings directly with streamflow, reservoir-level and groundwater-level measurements. While our inability to make reliable long-term weather forecasts prevent us from accurately predicting the onset or end of drought, responsible use of a combination of the techniques can provide a means by which planners can gauge the severity of drought, and respond to the problem at hand.

OVERVIEW OF MISSOURI DROUGHT SUSCEPTIBILITY

Missouri is hydrologically and geologically diverse. The average annual rainfall ranges from about 34 inches in northwest Missouri to about 48 inches in southeast Missouri.

AVERAGE ANNUAL PRECIPITATION



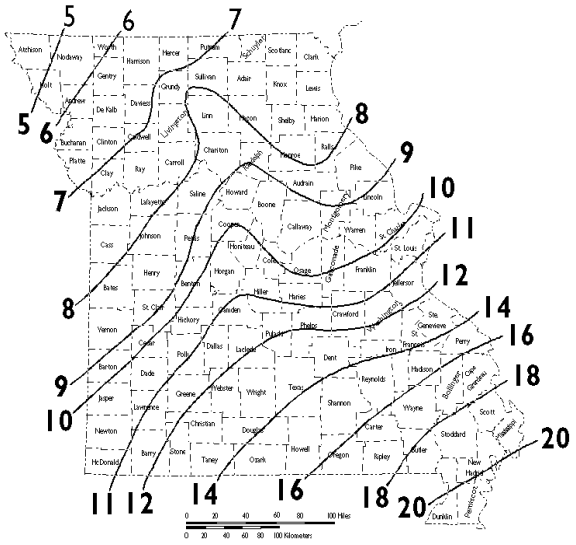
The average annual runoff from precipitation varies from less than 5-inches to more than 20-inches per year.

The average annual lake evaporation ranges from less than 36-inches a year in the northeast part of the state to more than 44-inches a year in the southwest part.

Compared to most western states, even the driest areas of Missouri have enviable amounts of rainfall; however, some areas of the state are still water-short in terms of rainfall in relation to needs and uses.

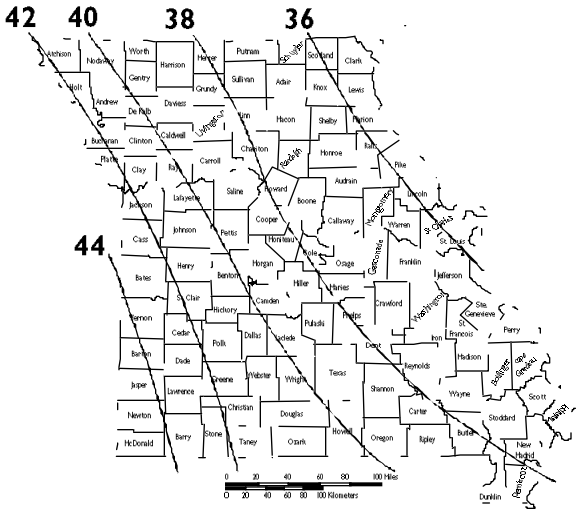
Water-use metering typically occurs only for human consumption and only

AVERAGE ANNUAL RUNOFF



in residential areas and in rural areas served by regional water systems.

AVERAGE ANNUAL LAKE EVAPORATION



SOUTHERN MISSOURI

Historically, most of the southern half of the state has abundant groundwater resources, making it less susceptible to problems caused by prolonged periods without rain. Even with decreased streamflow or lowered reservoir levels, groundwater is still a viable resource in southern Missouri.

The agricultural needs for water aren't as great here as they are in other parts of the state because row-crop farming is not extensive in southern Missouri. The only exception is in the southwestern and southeastern areas where irrigation is used.

NORTHERN AND WEST-CENTRAL MISSOURI

Most of west-central and northern Missouri are underlain by rocks that cannot be considered water-bearing formations. They yield only small amounts of water even during times of normal or above normal rainfall.

During periods of drought when no recharge is occurring, adequate amounts of water cannot be pumped from the rock formations of northern Missouri to supply even domestic needs.

Most streams in northern Missouri do not receive appreciable groundwater recharge. During periods of drought, these streams are generally reduced to a series of pools or may become completely dry.

Streams and water impoundments are the only sources of water during droughts and when a drought is prolonged, these sources are at risk.

This may be particularly true where treated or untreated wastewater constitutes a significant percentage of the base flow of streams during drought periods.

Agriculture in west-central and northern Missouri is usually the first to feel the effects of drought. Row-cropping is more extensive in this part of the state and except on the floodplains of major rivers, where alluvial groundwater resources are

adequate, irrigation is generally not feasible. In many areas where irrigation is used, groundwater may require supplemental surface-water supplies.

The water needs of livestock in northern Missouri are typically supplied by farm ponds; however, during prolonged drought, farm ponds may become inadequate.

Prior to any detailed planning and determination of available alternatives, the state should be divided into regions prioritized according to drought susceptibility (see map on page 17).

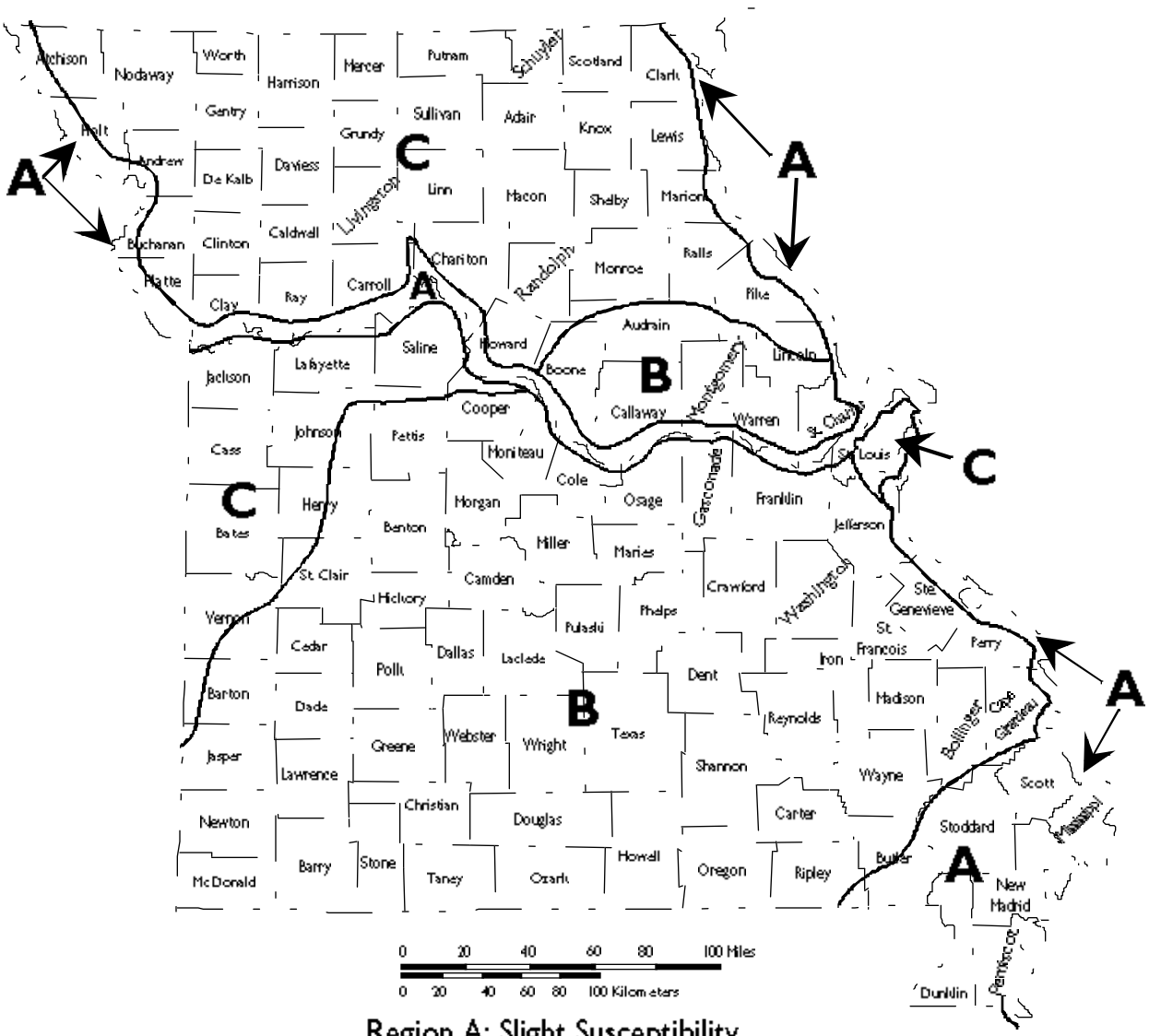
Region A has very little drought susceptibility. It is a region underlain by sands and gravels (alluvial deposits). Surface and groundwater resources are generally adequate for domestic, municipal, and agricultural needs.

Region B has moderate drought susceptibility. Groundwater resources are adequate to meet domestic and municipal water needs, but due to required well depths, irrigation wells are very expensive. The topography generally is unsuitable for row-crop irrigation.

Region C has severe drought vulnerability. Surface water sources usually become inadequate during extended drought. Groundwater resources are normally poor, and typically supply enough water only for domestic needs. Irrigation is generally not feasible. When irrigation is practical, groundwater withdrawal may affect other users. Surface water sources are used to supplement irrigation supplied by groundwater sources.

Since the areas in this region with poor groundwater yield and quality are the areas that appear to be the most vulnerable to drought, they should be the focus of drought planning activities. They should be designated Priority Drought Management Areas and be given a high priority relative to drought mitigation and water supply regionalization activities. If, during a severe drought, the effects of the drought begin to affect surrounding counties, the borders of the management area can be expanded to include affected areas.

DROUGHT SUSCEPTIBILITY



Region A: Slight Susceptibility
Region B: Moderate Susceptibility
Region C: High Susceptibility

RESERVOIRS AND LAKES

Lakes Per County - 20 Acres and Larger

A = 0-10	D = 51-70
B = 11-30	E = 71-90
C = 31-50	F = 91-110

CONCEPT OF RESPONSE PLAN OPERATIONS

The following is a generalized drought response plan based on plans developed by several states in areas hydrologically, geologically, socially, politically, economically, and environmentally similar to Missouri.

PHASES OF DROUGHT RESPONSE SYSTEM

Missouri's Drought Response System is divided into four phases:

PHASE 1 - ADVISORY PHASE

A drought monitoring and assessment system is required to provide enough lead time for state and local planners to take appropriate action. During normal conditions, DNR and the National Weather Service (NWS) will supply water monitoring data and analysis of anticipated consequences to the State Emergency Management Agency (SEMA) on a monthly basis, based on the assumption that the conditions will continue.

PHASE 2 - DROUGHT ALERT

A. When the Palmer Drought Index reads -1.0 to -2.0, and streamflow, reservoir levels and groundwater levels are below normal over a several month period, and/or the Drought Assessment Committee (DAC) determines Phase 2 activities are required using other drought determination methods listed above, then the Governor will be requested to make a drought alert declaration for those regions or drought management areas of the state experiencing these conditions. The Director of the Department of Natural Resources will initiate activation of the DAC.

B. Drought Assessment Committee (DAC): The Director of the Department of Natural Resources or his designee will activate and chair the DAC. A DAC vice-chair will be selected by the committee from among participating DAC members. The DAC will consist of representatives from the following agencies: (The following list is not all inclusive.)

1. **Missouri Department of Natural Resources**
   a. Office of the Director
   b. Division of Environmental Quality
   c. Division of Geology and Land Survey-Water Resources
   d. Division of State Parks
   e. Division of Energy
2. **Missouri Department of Agriculture**
   a. Office of the Director
   b. Policy and Planning

3. **Missouri Department of Public Safety**
   a. Office of the Director
   b. State Emergency Management Agency
   c. Adjutant General
   d. Missouri National Guard
   e. Missouri Water Patrol
   f. Air National Guard
4. **Missouri Department of Health**
   a. Office of the Director
   b. Bureau of Epidemiology
5. **Missouri Department of Conservation**
   a. Conservation Commission
   b. Planning Division
   c. Engineering Division
   d. Operations Division
6. **Missouri Department of Economic Development**
   a. Office of the Director
   b. Public Service Commission
   c. Community Development Programs
7. **Missouri Department of Social Services**
   a. Office of the Director
   b. Division of Family Services
   c. Division of Medical Services
8. **University of Missouri-Columbia**
   a. Cooperative Extension Service
   b. Department of Agriculture
   c. College of Engineering
   d. State Climatologist
9. **U.S. Department of Commerce**
   a. National Oceanic and Atmospheric Administration/ National Weather Service
10. **U.S. Department of Agriculture**
    a. Natural Resource Conservation Service
    b. Consolidated Farm Service Agency
    c. Forest Service
11. **U.S. Army**
    a. Corps of Engineers
    b. Army Reserves
12. **U.S. Department of the Interior**
    a. Geological Survey, Water Resources Division
    b. Fish and Wildlife Service
13. **U.S. Environmental Protection Agency**
14. **Federal Emergency Management Agency**

C. The Drought Assessment Committee shall carry out these and other tasks as assigned:
   1. Provide a reporting system format and issue drought status through phases 2-4 of a drought.
   2. Provide a water availability report (*Water Watch Report*) with forecasted weather reports to the Governor.
   3. Recommend the activation of and coordinate with representatives of Impact Task Forces (ITF)(to be explained below) for the development of additional assessment information and the identification of emergency needs.
   4. Make recommendations to the Governor concerning state-level or regional response and recovery.
   5. Make recommendations relating to proposed State actions, including the activation of Impact Task Forces to monitor and review potential impacts on the

State's agriculture, economy, environment, and natural resources.

6. Identify resource deficiencies that may aggravate drought effects.
7. Coordinate with the Governor and others as needed to develop drought legislation.
8. Evaluate how the plan is working, from information provided by the Impact Task Forces and local water shortage teams.
9. Produce drought reports as necessary.
10. Activate ITFs, charge each ITF with a specific topic and select chairperson and membership of each ITF.

D. Impact Task Forces: The Impact Task Forces are composed of agency staff who are technical experts. The ITFs gather, review and provide specific, detailed reports and analyses. The ITFs shall report their findings and recommendations to the DAC. The following are a partial listing of potential ITF committees and topics:

1. Agriculture: livestock, crops, farm ponds, irrigation, roughage/forage
2. Natural Resources and Environmental: fish, forests, wildlife, aquifers, rivers and streams,
3. Recreation: tourism and navigation
4. Water Supplies and Wastewater: public, private, commercial, industrial, utilities
5. Health: human health, water contamination
6. Social: demographic and sociological impacts
7. Economic: personal and business income impacts, tax revenue impacts, federal and state assistance
8. Post Drought Evaluation: review and analysis of impacts of drought on items 1 through 7, recommendations for mitigation, crisis intervention and planning, recommended changes and expansions to the *Missouri Drought Response Plan*

PHASE 3 - CONSERVATION PHASE

Phase 3 is activated:

- when the Palmer Drought Severity Index is between -2 to -4;
- when the DAC determines that Phase 3 activities are required using other drought determination methods listed above, and in what Drought Management Areas;
- and when stream flows, reservoir levels and groundwater levels continue to decline, and forecasts indicate an extended period of below normal precipitation. Monitoring, oversight, and analysis activities are then increased.

The Conservation Phase would return to a Drought Alert:

- when precipitation increases,
- streamflows, reservoir levels and groundwater levels stop their decline, and
- when the Palmer Drought Index rises to -2.0 or higher. The DAC determines other methods listed above.

The Drought Task Force and Local Teams evaluate plan performance and report to the DAC. See Appendix A, for details of Water Conservation.

PHASE 4 - DROUGHT EMERGENCY (POSSIBLE LOCAL RATIONING PHASE)

Phase 4 is activated:

- when the Palmer Drought Severity Index is lower than -4.0; and

♦ when the DAC determines that Phase 4 activities are required by using other drought determination methods listed above, and in what regions. The Governor may issue a Drought Emergency in this case.

During this drought phase, the Drought Task Forces and the Local Teams will evaluate the *Missouri Drought Response Plan* and report to the DAC on the efficiency of the plan in addressing problems. The DAC should modify the plan as needed.

The Governor's declaration empowers State agencies to review allocation of supplies in communities not adequately responding to their water shortage, and to implement emergency programs and actions. This may include provisions for limiting installation of service to new customers.

Drought Executive Committee (DEC): The Governor activates the DEC independently or after review of recommendation of the DAC. The DEC is composed of agency heads or their designee and other appropriate state representatives as identified below. The DEC is chaired by the Director of the Department of Natural Resources or an appointee named by the Governor and meets on a regular basis for the purpose of administering and coordinating drought assistance in Missouri. The Committee is charged with developing short and long-term recommendations and options for the Governor as they relate to agricultural assistance and protection of public and private water supplies. Recommendations and options will be based upon data provided by the DAC. The DEC membership will consist of the following representatives or their designee:

Governor's Delegate
State Representative - as named by the Speaker of the House
State Senator - as named by the President Pro Tem of the Senate
Attorney General
Director, Department of Natural Resources
Director, Department of Health
Director, Department of Agriculture
Director, Department of Economic Development
Director, Department of Conservation
Director, Department of Public Safety
Administrator, Employment Services
Chairman, Public Service Commission
Director, State Emergency Management Agency

Activation of a State Emergency Operations Center (EOC): The EOC, as provided for in the SEMA's Emergency Operations Plan, should be operating at various levels of activation throughout a drought in accordance with four Crisis Action System (CAS) levels for assessment and response:

(a) CAS-1 Normal monitoring phase (Phase 1),
(b) CAS-2 DAC monitoring (Phase 2),
(c) CAS-3 Partial EOC activations recommended by DAC to the Governor (Phase 3), and
(d) CAS-4 Full EOC activation as recommended by the DEC to the Governor (Phase 4).

When the Missouri Emergency Operations Center is activated, procedural plans will need to be implemented as soon as possible.

ORGANIZATION AND ASSIGNMENT OF RESPONSIBILITIES

ORGANIZATIONAL OVERVIEW

FEDERAL

The following organizations of the federal government may assist Missouri during drought emergencies with loans, grants and programs for material and personnel support:

U.S. Department of Agriculture
U.S. Department of Commerce
U.S. Department of Labor
U.S. Army Corps of Engineers
U.S. Department of Interior
U.S. Environmental Protection Agency
Small Business Administration
Federal Emergency Management Agency
General Services Administration

During a Presidentially declared drought emergency, FEMA may provide Emergency Response Teams (ERTs) in the State EOC to assist in the coordination of federal assistance.

STATE

The following state organizations may provide programs to local governments during drought emergencies:

Department of Natural Resources
Department of Health
Department of Agriculture
Department of Conservation
Department of Public Safety
Department of Economic Development
Department of Social Services
University of Missouri Extension Service
Crowder College

Monitoring by the DAC will be maintained throughout Phase 2 through Phase 4 with appropriate State assessment and response/recovery recommendations made to the Governor and the DEC.

Although some State assistance and resources are released for local use prior to formal declaration of a drought emergency by the Governor, most State assistance is available only after a State declaration or regional declaration by local authorities has been issued.

Attention should be given to overall water quality during all phases of any drought event, to ensure potable water for public use.

LOCAL

The following should also be considered as adjuncts to any plans, procedures,

policies, and laws related to drought that local communities have developed:

- Enactment of ordinances to assure equitable water distribution. Provisions for limiting installation of service to new customers during Phase 4, provided that human health and safety shall be the determining factor.
- Establishment of a Water Management Team made up of major water users, government executives, health, fire, and police representatives, and utilities. This team will determine and implement community activities (See Appendix 8, for details of Water Management Team representation).
- Prepare a local drought plan (See Appendix 4 for a Local Response Plan) in coordination with the terms of the State Emergency Operations Plan (EOP) as well as local EOP's.
- Establish local drought emergency public information and education programs.
- Maintain communications/coordination with the state EOC throughout the drought emergency.
- Evaluate local vulnerability to water shortages (See Appendix 5).

ASSIGNMENT OF RESPONSIBILITIES

1. **Department of Natural Resources**
   a. Provide chairperson(s) for DAC and DEC.
   b. Develop updates of *Missouri Drought Response Plan* for DAC for review and approval.
   c. Refer to sections A, B, C, and D in the Missouri EOP for state activation, alert, communications, public information and coordination functions applicable for all emergencies.
   d. Monitor water resources (quality and quantity) and report to the director or chair of the DAC under Phase 1, normal conditions.
   e. Provide information on available water resources within the state.
   f. Contact city officials to encourage adoption and enforcement of ordinances regarding conservation of water use.
   g. Review and update regional water-supply plans for each community.
   h. Assist water users to develop water conservation plans and programs.
   i. Monitor hydrologic and water-supply conditions, gather and interpret water data regarding supply, use and trends.
   j. Continue to collect water use data, publish annual reports and analyze usage statewide and regionally.
   k. Assist in education of the public concerning general water management needs and answer requests for water resource information.
   l. Assist in mediating conflicts of source utilization.
   m. Provide technical information regarding private water supplies.
   n. Recommend voluntary cutbacks in water usage.
   o. Initiate recommendations for water conservation based upon recognized priorities.

p. Coordinate with the Dept. of Health on release of drought-related health advisories.
q. Assist in encouraging cut backs of industrial use of water.
r. Chair the Public Water Supply Task Force.
s. Delegate staff for ITF and DAC membership.

2. **Department of Agriculture**
   a. Coordinate with U.S. Dept. of Agriculture in collection of information regarding critical shortages of food products and livestock feed.
   b. Develop state request for federal assistance and declaration of drought-related agricultural emergencies in coordination with the U.S. Dept of Agriculture.
   c. Plan for the emergency distribution of livestock feed.
   d. Chair the Agricultural Task Force.
   e. Assist in encouraging cutbacks in agricultural use of water.
   f. Delegate staff for ITF and DAC membership.
   g. Provide programs and assistance to local governments and individuals during drought emergencies.

3. **Department of Public Safety**
   a. Coordinate the use of Missouri National Guard water trailers, pipe and pumps for use by local communities.
   b. Refer to the State of Missouri Emergency Operations Plan for state activation, alert, communication, public information and coordination functions applicable for all emergencies.
   c. Coordinate drought-related press releases.
   d. SEMA will operate the EOC.
   e. Coordination and control of state and federal resources as applicable to cognizant state agency.
   f. SEMA will develop a state request, if necessary, for federal disaster declaration and federal assistance in drought emergencies.
   g. Delegate staff for ITF and DAC membership.

4. **Department of Health**
   a. Provide increased surveillance of private water supplies.
   b. Provide public instructions on means of disinfecting drinking water.
   c. Provide technical information regarding private water supplies.
   d. Delegate staff for ITF and DAC membership.

5. **Department of Conservation**
   a. Implement drought assistance programs as requested and technical assistance pertaining to fish and wildlife.
   b. Provide assessments of drought damage.
   c. Delegate staff for ITF and DAC/ DEC membership.

6. **Department of Economic Development**
   a. Provide direct technical assistance and technical assistance funding
   b. Regulated investor owned utilities advise PSC of their drought status, establish contact person

for weekly status report, and recommend conservation education plans.

c. Advise PSC regulated investor-owned utilities to enforce their tariffs with regard to voluntary and mandatory conservation measures.

d. Provide weekly reports on cur rent status of PSC regulated investor-owned utilities ability to provide service to their customers. The weekly reports will also contain any information the PSC drought coordinator would deem necessary to assist the Drought Task Force.

e. Monitor all events that impact on this or other PSC regulated utilities during this emergency.

f. Delegate staff for ITF and DAC membership.

7. **Department of Social Services**

a. Implement drought assistance programs as requested.

b. Provide assessments of drought damage.

c. Delegate staff for ITF and DAC membership.

8. **University of Missouri Extension Serice**

a. Coordinate with Regional Extension Specialists for local drought preparedness/response/recovery activities.

b. Provide information and reports to the DAC on drought notifications and conditions in counties.

c. Assist Regional Extension Spe cialists in distribution of drought related Emergency Public Information.

d. Delegate staff for ITF and DAC membership.

8. **Crowder College Environmental Resource Center**

a. Provide information and technical assistance on water treatment and wastewater.

b. Delegate staff for ITF membership.

9. **U.S. Department of Commerce (NWS)**

a. Implement drought assistance programs as requested.

b. Provide assessments of drought damage.

c. Delegate staff for ITF and DAC membership.

10. **U.S. Department of Agriculture (CFSA, NRCS and USFS)**

a. Implement drought assistance programs as requested.

b. Provide assessments of drought damage.

c. Delegate staff for ITF and DAC membership.

11. **U.S. Army (USCOE and Reserves)**

a. Implement drought assistance programs as requested.

b. Provide assessments of drought damage.

c. Delegate staff for ITF and DAC membership.

12. **U.S. Department of the Interi or (USGS and USF&WS)**

a. Implement drought assistance programs as requested.

b. Provide assessments of drought damage.

c. Delegate staff for ITF and DAC membership.

13. **U.S. Environmental Protection Agency**
    a. Implement drought assistance programs as requested.
    b. Provide assessments of drought damage.
    c. Delegate staff for ITF and DAC membership.

14. **Federal Emergency Management Agency**
    a. Implement drought assistance programs as requested.
    b. Provide assessments of drought damage.
    c. Delegate staff for ITF and DAC membership

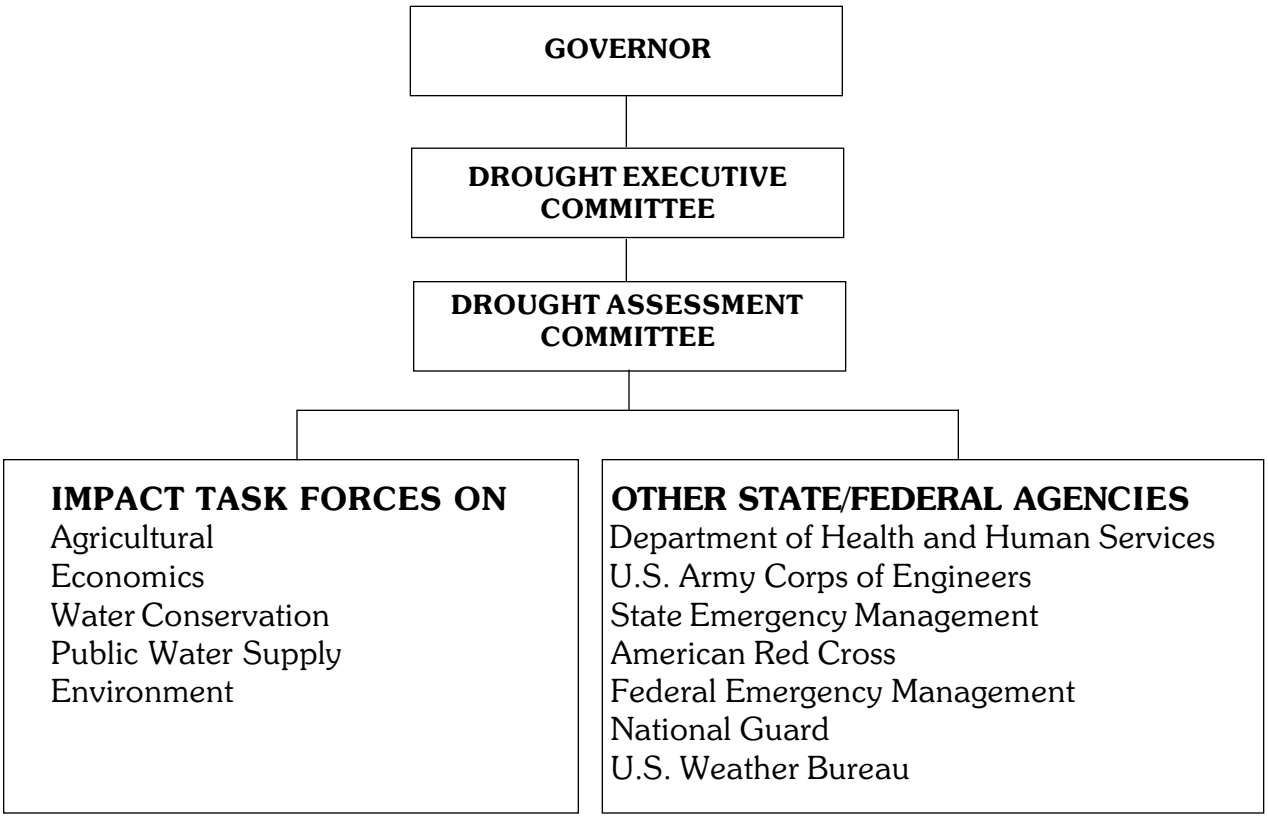
CONCLUSIONS

The objectives of this drought plan are specific and action-oriented. The Governor must support the development of the plan and initiate the process. Agreement within state agencies and with special and public interest groups is also an important part of implementation.

Planning, if undertaken properly and implemented during non-drought periods, can improve governmental ability to respond in a timely and effective manner during periods of emergency. The costs of preparedness are reduced considerably through the use of existing institutional structures and by incorporating the process into a comprehensive state water planning effort. An example would be the development of regional water supplies and transmission systems. Utilities should also be encouraged to use available funds to upgrade metering. If leaks are detected, they should be repaired or distribution piping replaced where necessary.

APPENDIX 1

MISSOURI DROUGHT RESPONSE PLAN ORGANIZATIONAL CHART



APPENDIX 2

STATE DROUGHT IMPACT TASK FORCES

Each state agency named to an Impact Task Force will name an agency drought coordinator and, by their own initiative, take appropriate measures in response to drought related problems. Coordination with other agencies and timely implementation of effective measures by individual agencies should not be hindered by a strict review and approval process. The Task Forces will coordinate and facilitate individual agency actions and oversee cooperative efforts. The representatives must be able to speak for their agency and have authority to make reasonable commitments toward effective cooperation and coordination.

The ITF's will function as technical work groups. Each Impact Task Force activated by the DAC will, at time of activation, be charged with specific tasks and duties.

The duties and activities of the Task Forces are to include, but are not limited to:

- Develop, revise and update, as necessary, Task Force guidelines or procedures.
- Establish procedures for coordination with other task forces, state and federal agencies, local government, and public/or private groups.
- Identify key contacts in state, federal, and private support groups.
- Review existing reporting, analyze capabilities, and identify information gaps. Recommend response levels and activities and analyze barriers to response or special needs.
- Report to the Drought Assessment Committee on a regular basis during the conservation phase and on a weekly basis in a drought emergency
- Maintain supporting data and records of activities.
- When deactivated, prepare a final report on activities and submit it to the Director or Chair of the Drought Assessment Committee.
- The final report should include proactive recommendations that will help to mitigate and prevent future drought relate problems, specific to the charge of the task force.

APPENDIX 3

SUGGESTED RESPONSE PRIORITY WATER-USE CLASS

CLASS 1: ESSENTIAL WATER USES

Domestic Use: Water in amounts reasonably needed to sustain human life, and to maintain reasonable standards of hygiene, cleanliness, and sanitation.

Health Care Facilities: Patient care and rehabilitation

Public Use: Firefighting - local authorities should institute a "burn ban" at this time, allowing no outside burning.

For health and public protection purposes, as specifically approved by the health official and the municipal governing body, should include water supply and wastewater treatment.

Water is necessary for the operation of electric power generation, essential for the operation of key military facilities, the operation of telephone communications, water and wastewater systems and other health-related needs.

CLASS 2: SOCIALLY OR ECONOMICALLY IMPORTANT USES OF WATER

To the extent that sources of water other than fresh water are not available or feasible to use, socially or economically important uses of water include:

(a) agricultural irrigation for the production of food and fiber and the maintenance of livestock;

(b) watering by commercial nurseries at a minimum level to maintain stock;

(c) water uses by arboretums and public gardens of national, state, or regional significance where necessary to preserve specimens;

(d) water use by sod producers and the turf industry to a minimum level to maintain stock;

(e) use of fresh water at a minimum rate necessary to implement revegetation following earth moving, where such revegetation is required pursuant to an erosion and sedimentation control plan adopted pursuant to law or regulation;

(f) commercial laundromats;

(g) restaurants, clubs and eating establishments;

(h) commercial air conditioning, including refilling for start-up at the beginning of the cooling season, make up water during the cooling season, refilling specifically approved by health officials and the municipal governing body where the system has been drained for health, protection or repair purposes; and

(i) schools, churches, motels/hotels, similar commercial establishments.

CLASS 3: NON-ESSENTIAL USES OF WATER

Non-essential uses of water include:

(a) outdoor commercial and non-commercial watering (public or private);

(b) fountains, reflecting pools and artificial waterfalls used for ornamental purposes;

(c) gardens, lawns, parks, playing fields and other recreational areas;

(d) filling and operation of swimming pools (public or private);

(e) watering of golf course greens to the extent that sources of water other than fresh water are not available or feasible to use;

(f) washing of all motor vehicles including commercial car and truck washes and private vehicles by owner;

(g) use of fire hydrants and sprinkler caps for testing any fire apparatus and for fire department drills (unless specifically approved by the health officials of the municipality). In general, the use of fire hydrants for all purposes except for fire fighting, health protection or certain testing and drills by the fire department if it is in the interest of public safety and is approved by the governing body.

(h) any flushing of sewers and hydrants except as needed to ensure public health and safety, and approved by health officials and the governing body;

(i) air conditioning and refilling cooling towers after draining except for refilling for start-up at the beginning of the cooling season, makeup of water during the cooling season, refilling specifically approved by health officials and the governing body where the system has been drained for health protection or repair purposes.

APPENDIX 4

A LOCAL WATER SHORTAGE RESPONSE PLAN

(under local ordinances)

This plan is the responsibility of the local water shortage management team. This group provides essential support to officials making difficult decisions during water shortage times. It is also responsible for determining how much water is available, and how much will be needed. If the assessment shows no potential for shortage, then officials should continue to monitor the supply and be prepared to act if the situation changes. If the assessment of supply and demand shows the potential for a water shortage, the Task Force should begin planning to take the following actions, as needed:

1. Direct local water utilities to locate and correct leaks,

2. Explore possibilities for supplementing the water supply such as regional water supply and interconnection with other water utilities,

3. Consider changing pricing to discourage water use (should the drought last for an extended period of time or be severe),

4. Direct the community to take conservation measures according to the severity of the shortage.

5. Aspects of the *Missouri Drought Response Plan* will be tested and exercised on a regular basis, but at least annually under the State Emergency Operations Plan administered by the State Emergency Management Agency.

There are four phases of severity:

PHASE 1 - ADVISORY PHASE

During the Advisory Phase do the following:

(a) issue a water shortage advisory,

(b) set conservation goals,

(c) inform the public of the potential problem, and

(d) request voluntary conservation.

PHASE 2 - ALERT PHASE

During the Alert Phase do the following:

(a) issue a water shortage alert,

(b) set more stringent conservation goals, which can include activities to educate utility owners and operators that unaccounted water (water lost in transmission) must be measured and reduced to a reasonable limit such as 10 to 15 percent,

(c) ban Class 3 non-essential uses,

(d) inform the public of the problem,

(e) request voluntary conservation of all water use, and

(f) monitor and enforce compliance.

PHASE 3 - EMERGENCY PHASE (FIRST STAGE)

During the Emergency Phase First Stage:

(a) issue a water shortage emergency statement,

(b) set more stringent conservation goals,

(c) ban Class 3 use, restrict Class 2 use,

(d) inform the public,

(e) enact conservation pricing, and

(f) monitor/enforce compliance/restrictions.

PHASE 4 - EMERGENCY PHASE (WATER RATIONING STAGE)

During the Water Rationing Emergency Phase:

(a) begin mandatory allocation of water,

(b) immediately reduce usage by 25 to 50 percent (local option),

(c) inform the public,

(d) practice stricter conservation pricing,

(e) set new conservation goals,

(f) monitor all shortages and compliance, and

(g) enforce allocations as necessary.

Secured Water Allocation to individual users: This would only occur at times when the supply was almost totally depleted, and would only be for life-threatening cases.

In many shortage situations, finding additional supplies is impractical. Planning and conservation measures designed to maintain supplies are frequently more effective than last minute attempts to supplement supplies.

ADVISORY PHASE (PHASE 1)

1. When to declare an advisory:

(a) an advisory should be declared when conditions indicate the potential for serious water-supply shortages,

(b) when static water levels drop in wells, or when pumping rates decline, or when drawdowns increase while pumping (measurements should be made weekly),

(c) when the flow of streams is abnormally low, or when demand is 20 to 40 percent of flow,

(d) a potential shortage would exist when there are less than 180, but more than 120 supply days left in reservoirs and impoundments (supply should be reassessed weekly).

2. What to do in an advisory:

(a) notify the affected public and request voluntary conservation expressed as a percentage of normal use or a specific gallon amount,

(b) conduct an intensive public information campaign,

(c) enlist support from the local Water Shortage Management Task Force because they are important to success,

(d) allow for the fact that in most circumstances, voluntary measures only reduce water use by 5 to 15 percent,

(e) develop action plans for alternate supply sources. The action plans would be constructed from plans developed as drought contingencies as approved by the local Water Shortage Management Teams.

ALERT PHASE (PHASE 2)

1. When to declare an alert:

(a) when there are visible or measurable signs that supplies are significantly lower than the seasonal norm and are diminishing,

(b) when there are signs of shortage in a well that are abnormally large or there is a rapid increase in drawdown or a large decrease in the static water level,

(c) when the demand is 40 to 65 percent of flow of springs or streams, as determined from comparisons with historical records (the flow should be measured twice weekly. The alert can be removed when demand is less than 40 percent for a 4-week period.),

(d) when there are less than 120 but more than 60 days supply remaining in a reservoir impoundment (for reservoirs in small watersheds, more conservative figures are appropriate).

2. What to do in an alert:

(a) chose and implement mandatory measures (bans or restrictions on specific uses) should be chosen and implemented,

(b) assess penalties for non-compliance (penalties should be graduated for repeated violations),

(c) implement an education effort to encourage water conservation intensified to exceed 50 percent water conservation (may require water rationing),

(d) develop a firm commitment to alternate supply processes such as pipelines, hauling, and agreements with nearby water supplier.

EMERGENCY PHASE (PHASE 3)

1. When to declare an emergency:

(a) if the drawdown and static water level of a well continues to go down, a point should be chosen to declare an emergency situation based on prior knowledge of the well,

(b) if the demand on springs and streams is 65 to 75 percent of flow (measure the flow daily),

(c) when there are less than 60 but more than 30 days available supply in reservoirs and impoundments (The time frame is especially critical for supplies in small drainage basins so the supply should be reassessed daily).

2. What to do in an emergency:

(a) implement stringent conservation measures,

(b) enact pricing measures and additional mandatory restrictions (economic rationing),

(c) expanded educational efforts and explain pricing measures and restrictions,

(d) put water conservation ordinance in place, and

(e) put alternate supply sources into service.

EMERGENCY WATER RATIONING PHASE (PHASE 4)

1. When to declare water shortage rationing:

(a) when the water supply is clearly inadequate to meet predicted demands, declare water shortage rationing on metered systems. Unmetered users must somehow be monitored. Efforts should be implemented to finance meters prior to drought. This has other positive impacts on system operation;

(b) when the supply appears to be running out in well;

(c) when demand on springs and streams is 75 percent or more of their daily measured flow;

(d) when less than 30 day supply is available in reservoirs and impoundments.

2. What to do in rationing:

(a) be fair and equitable,

(b) use the method most appropriate for your community (if you use flat percentages it penalizes conservation but if you use variable percentages it is better for small users),

(c) penalty assessments established earlier are to be enforced,

(d) set a maximum allowable usage,

(e) allow maximum per capita use (rationing and pricing can reduce use of water by 30 to 70 percent).

Provisions for limiting installation of service to new customers, where the addition of new customers would cause impairment of existing service to tenured customers in the form of low water pressure, bacterial contamination and increased costs to original customers. Limitation of service to new customers should be reviewed on a case-by-case basis with human health and safety being the primary factor.

The review should include the following secondary considerations:

(a) individuals who previously refused service during normal, non-drought conditions,

(b) normal construction of new residential dwellings and refurbishment of existing dwellings that would typically require public water service hook-up under normal conditions,

(c) normal business or industrial construction or development where public water service would be required,

(d) pre-planned and previously approved water service expansion,

(e) long term implications for an area's economic, social and environmental stability and growth.

During extremely severe drought, the Governor can declare mandatory allocation of water in communities not adequately responding to shortages.

When the situation has returned to normal, the Advisory, Alert, Emer-gency, and Rationing phases should be decreased in reverse order of implementation. It would be wise to have a buffer period prior to starting a return to normal conditions. Too rapid a return could be disastrous if drought conditions persisted. Water shortage response efforts and results should be recorded and evaluated for us during future problems.

The Department of Natural Resources' Public Drinking Water Program has good examples of local drought plans. It would be advisable for local communities to see these plans and pick a plan which best fits their conditions. The most important thing is to <u>have a plan that can be implemented.</u>

APPENDIX 5

EVALUATING VULNERABILITY AND DEMAND

Missouri could avoid or postpone many impacts of drought if citizens and communities were already conserving and using their water resources efficiently. To encourage wise use, state and federal agencies should consider offering Water Consumption Audits for all categories of water usage.

EVALUATING VULNERABILITY TO WATER SUPPLIES

Several factors influence the determination of whether raw water supply and storage are adequate:

1. Reliability - How often has the volume of source approached the current level of demand, and under what conditions?
2. Resilience - How quickly would the source recover from a shortage?
3. Flexibility - How accessible are alternate sources?
4. Expansion of Service Area - What impacts would accompany installation of service to new customers on tenured customers and conversely the impacts of denial of service to new customers?
5. Transmission Losses - How much raw and treated water is lost by leaking transmission lines?
6. Public Safety - What are the requirements to maintain adequate levels of human health, safety and welfare as it pertains to drinking water, fire protection, adequate water pressure, and prevention of water system contamination?

If demand is normally 80 percent of system capacity, it is likely to reach 100 percent or more if there is a drought. Conservation is the only method of coping with demand that surpasses treatment and distribution capacity.

DETERMINATION OF ABILITY TO MEET DEMAND

Each situation must be analyzed separately by local governments and water utility managers to determine how to respond to a watch or warning.

1. Estimating demand: a well-operated water utility may have as much as 15 percent loss, and many systems have 30 percent or more. In estimating demand you should include:

(a) true losses related to leakage, metering and billing systems

(b) the percent of total water pumped that is accounted for at service meters

(c) the estimated amount of water that is unmetered

Future demands and water use projections should be performed by a qualified economist. Contact DNR, Natural

Resource Conservation Service (NRCS) or a consultant for advice.

2. Estimating supply:

(a) Use specific capacity to determine the "wellness" of your wells. There is cause for concern when the capacity decreases to 80 percent. Static water levels and drawdowns should be measured on a regular basis.

(b) Without historical records for the wells, a supply/demand figure cannot be determined. Current drawdown and specific capacity figures must be used. Monitoring for a few weeks can tell if the well is significantly decreasing in supply capability due to low water or overdrawn conditions. Groundwater consultants, the USGS and DNR's Division of Geology and Land Survey, Groundwater Section can assist in determining well capability and spacing needs.

(c) Monitor the elevation or stage of water in the impoundments through use of a staff gage.

(d) Contact the NRCS and DNR to determine if reservoir sediment surveys have been made on the impoundment. If surveys have been made so that volumetric estimates can be made for the reservoir bottom contours, then estimate the volume of storage remaining. The elevation of the top of the surface water intake structure should be used as the bottom of the reservoir for calculating the remaining storage available. Due to summer stratification and chemical processes associated with the hypolimnion of stratified reservoirs, the bottom one-third of many Missouri reservoirs is very difficult to process for water supply. The bottom one-third often contains excessive levels of iron, manganese, organics and turbidity. Accumulated sediments may also deplete storage so sediment survey information is critical during times of low reservoir capacity and must be known to calculate the FIRM YIELD of a reservoir.

(e) If available, daily flows into and out of the reservoir are useful in determining reservoir yield. To be reliable, evaporation and reservoir seepage also must be taken into account. The DNR recommends using the Drought of Record (1953-1957) to determine the critical period, and calculations of inflow and evaporation to determine future inflows during a drought cycle and for all new water supply reservoirs. Engineering consultants are available to assist with these calculations. Advice can be obtained from the NRCS, DNR, and USGS.

(f) Many small water supply impoundments were originally designed with very little carryover storage. A safe and reliable groundwater supply system should be designed to operate under extreme drought conditions and be able to withstand the 5 year drought of the 1950s. Interconnections and agreements between suppliers are very productive in time of water supply or distribution outages.

APPENDIX 6

POST-DROUGHT EVALUATION PROCEDURES

The Post-Drought Evaluation Team (ITF or DAC) should address the following questions as a part of the evaluation process:

(1) Was the drought plan followed? If not, why not?

(2) Were the actions taken and measures implemented effective in mitigating the impact of the drought? Which actions and relief measures were effective and which were not?

(3) Should the plan have included other actions or assistance measures?

(4) Did aid reach all affected groups in the stricken area? If not, why not? How were the target groups for aid identified?

(5) Were the measures timely in relation to the events of the drought period?

(6) Was it possible to correct errors during the emergency?

(7) What financial and human resources were allocated to the relief effort? Where did the resources come from and how were they controlled?

(8) How efficient was the logistical support and the available infrastructure? What obstacles were encountered that reduced the efficiency of the response?

(9) How effective was the coordination of state and federal response efforts? How did this cooperation affect the flow of information or assistance?

(10) Was media coverage accurate and realistic in providing details of the event? What kinds of media were involved? What role did they play in the emergency?

The following questions are an example of a post-drought evaluation review designed by the Kentucky EPA to assist in evaluating drought response. Many of them are modeled after questions developed by the International Drought Information Center.

(1) What unit of your agency was active in the water shortage response? How was this decided?

(2) What are the normal responsibilities of this section? Has drought response been incorporated in the operations of this unit?

(3) How were upper level managers kept informed of activities? With what frequency?

(4) What are the responsibilities of your agency in case of drought-related water shortages? What information or cooperation do you need from other agencies to carry them out? Was this communication and activity adequate? How could it be improved?

(5) What other agencies did you report to during the drought? What media

were used and with what frequency? Name of person responsible. Was the result satisfactory?

(6) What other agencies reported to yours? What media were used and with what frequency? Who was responsible? Was the result satisfactory?

(7) Were the actions taken by your agency effective in mitigating the impacts of drought? Which measures were effective and which were not? What activities should be added?

(8) What financial and human resources were allocated to the relief effort? Where did the resources come from and how were they controlled? How much time and money were involved?

(9) Please provide any impact estimates prepared by your agency. Include costs, losses, and gains from the drought, in terms of dollars and/or the impact on the environment and resource base.

(10) Any other recommendations or comments?

APPENDIX 7

WATER CONSERVATION

The measures listed below are suggestions for wise water use. They are listed by use and condition. Naturally, all such measures are even more appropriate during worsening drought conditions.

INDOOR RESIDENTIAL USE

Conservation for Normal Conditions

♦Use dishwashers only when they are full. Washing dishes by hand (don't let the tap run!) saves about 25 gallons.

♦Adjust water level on clothes washing machines, if possible. Use full loads only if not adjustable.

♦Turn off faucets while brushing teeth, etc. This saves about 5 gallons per day.

♦Reduce water used per flush by installing toilet tank displacement inserts. A plastic jug can be used as an alternative. DO NOT USE BRICKS! They disintegrate when soaked and the resulting grit hinders closing of the flap valve.

♦Do not use the toilet as a trash can.

♦Use sink and tub stoppers to avoid wasting water.

♦Keep a bottle of chilled water in the refrigerator for drinking.

♦Find and fix leaks in toilets, which can leak silently. The following method can be used to see if this is occurring: place a drop of food coloring in the upper tank and do not flush for 30 minutes. If color appears in the bowl, there is leakage.

♦Find and fix leaks in faucets and water-using appliances. Faucets can usually be fixed cheaply and quickly by replacing washers.

♦Adapt plumbing with flow-restricting or other water-saving devices. These are usually inexpensive and easy to install. See list of devices in Appendix C.

♦Learn to read your water meter so you can judge how much water you use and what difference conservation makes.

Conservation for Water Shortage Advisory or Alert

(in addition to measures listed above)

♦Take shorter showers and shallower baths. Saves about 25 gallons.

♦Reduce the number of toilet flushes per day. Each flush uses about 5 gallons (2-3 gallons if you have water-saving toilets).

♦Don't use a garbage disposal.

♦Use non-phosphate detergent and save laundry water for lawns and plants.

Conservation for Water Shortage Emergency or Rationing Phases

(in addition to measures listed above)

♦Turn off shower while soaping up.

♦Use disposable eating utensils.

OUTDOOR RESIDENTIAL USE

Conservation for Normal Conditions

Lawns

♦Water before 10:00 A.M. to prevent evaporation, which occurs during the hottest part of the day. Morning is better than evening, when the dampness encourages growth of fungus.

♦Water only when lawn shows signs of wilt. Grass that springs back when stepped on does not need water.

♦Water thoroughly, not frequently; long enough to soak roots. A light sprinkling evaporates quickly and encourages shallow root systems. Water slowly to avoid runoff.

♦Do not let the sprinkler run any longer than necessary. In an hour, 600 gallons can be wasted.

♦Allow maximum of one inch of water per week on your lawn. To measure, place cake tins outside to collect rain and water from sprinklers.

♦Use pistol-grip nozzles on hoses to avoid waste when watering flowers and shrubs.

♦Aerate lawns by punching holes 6 inches apart. This allows water to reach roots rather than run off surfaces.

♦Mow Kentucky bluegrass no shorter than 2 to 3 inches high, to hold moisture.

♦Position sprinklers to water the lawn, not the pavement.

♦Avoid watering on windy days when the wind not only blows water off target, but also causes excess evaporation.

♦Keep sprinkler heads clean to prevent uneven watering.

♦Adjust hose to simulate a gentle rain. Sprinklers that produce a fine mist waste water through evaporation.

♦Know how to turn off an automatic sprinkler system in case of rain.

♦Use an alarm clock or stove timer to remind you to shut off sprinklers that don't have timers.

Vegetable and Flower Gardens

♦Water deeply, slowly and weekly. Most vegetables require moisture to a depth of six to eight inches.

♦Keep soil loose so water can penetrate easily.

♦Use mulch around plants and between rows to hold in moisture.

♦Keep weeds out to reduce competition for water.

♦Put the water where you want it and avoid evaporation by using soil-soakers or slow-running hoses, not sprinklers.

Trees and Shrubs

♦Water deeply using a soil-soaker.

♦Water only when needed. Check the depth of soil dryness by digging with a trowel. While the surface may be dry, adequate moisture may be retained beneath the surface.

♦Mulch to reduce evaporation. A 2 to 3 inch layer of wood chips, pine needles, grass clippings, or straw keeps the soil cool in summer. Mulch adds landscape interest and reduces weeds, and the few weeds that do grow are easy to uproot.

♦Dig troughs around plants to catch and retain water.

♦Water plants growing in full sun more often than those in shade.

♦Do not use sprinklers. Apply water directly at base of plant.

♦Do not fertilize during the summer. Fertilizing increases a plant's need for water.

♦Postpone planting until fall or spring when there is generally less need for water.

♦Install trickle-drip irrigation systems close to the roots of your plants. By dripping water slowly, the system doesn't spray water into the air where it can be lost through evaporation. Use soil probes for large trees.

♦Water when it is cloudy, at night, or even when a light rain is falling.

CONSERVATION FOR ADVISORY CONDITIONS

(in addition to measures listed above)

♦Do not allow children to play with hose or sprinklers.

♦Limit car washing.

♦Be ready to catch rainfall that occurs. Place containers under downspouts.

♦Use leftover household water, if available.

♦Consider delaying the seeding or sodding of new lawns.

♦Determine the amount of water being used outdoors by comparing water bills for the summer and winter.

CONSERVATION FOR ALERT CONDITIONS

(if outdoor watering is allowed in addition to measures listed above)

♦Vegetable gardens and food trees should be given minimal amounts of water on an individual basis only.

♦Do not water lawns and inedible plants.

♦Do not use sprinklers.

Most outdoor watering is prohibited under emergency conditions.

HOSPITAL AND HEALTH CARE FACILITY USE

♦Reduce laundry usage or services by changing bed linen, etc., only when necessary to preserve the health of patients or residents.

♦Use disposable food service items.

♦Eliminate, postpone, or reduce, as may be appropriate, elective surgical procedures during the period of emergency.

INDUSTRIAL USE

♦Identify and repair all leaky fixtures and water-using equipment. Give special attention to equipment connected directly to water lines, such as processing machines, steam-using machines, washing machines, water-cooled air conditioners, and furnaces.

♦Assure that valves and solenoids that control water flows are shut off completely when the water-using cycle is not engaged.

♦Adjust water-using equipment to use the minimum amount of water required to achieve its stated purpose.

♦Shorten rinse cycles for laundry machines as much as possible; implement lower water levels wherever possible.

♦For processing, cooling and other uses, either reuse water or use water from sources that would not adversely affect public water supplies.

♦Advise employees, students, patients, customers, and other users not to flush toilets after every use. Install toilet tank displacement inserts; place flow restructure in shower heads and faucets; close down automatic flushes overnight.

♦Install automatic flushing valves to use as little water as possible or to cycle at longer intervals.

♦Place water-saving posters and literature where employees, students, patients, customers, etc. will have access to them.

♦Check meters on a frequent basis to determine consumption patterns.

♦Review usage patterns to see where other savings can be made.

APPENDIX 8

THE LOCAL WATER SHORTAGE MANAGEMENT TEAM

During years of drought, and in communities that regularly experience water shortages, a local water shortage management team is important to successful response. If water runs short in your community there will be difficult decisions to make. A water shortage management team provides support for making and implementing those decisions, ensuring an appropriate and effective community response.

REPRESENTATION

A local team should include representatives of major water users, officials responsible for county health and safety, and persons who can help design and implement an effective information/education program. A reasonable size is 7 to 15 members. These could be chosen from the following sources. Those marked with an asterisk (*) are necessary participants.

Board of Health
Businesses (especially large water users)
Chamber of Commerce
Churches
* City Administration
Conservation District
Conservation Groups
* County Coordinator, Disaster and Emergency Services
County Health Department
Officials
Division of Water, Regional Office Representative
Fire Chief
Industries (both self-supplied and those when purchase from municipal supplies)
* Legal representative
Media representatives (TV, radio and newspapers)
Police Chief
Professional Groups
PTA
Superintendent of Schools
* Water District or Utility Personnel
Water Superintendent

APPENDIX 9

PRICING

The costs of running a utility during a drought (emergency hook-ups, publicity, etc.) will increase, while revenues from water sales will decrease (as consumers use less). Officials should consider a rate schedule to generate revenues during the drought, when users are likely to be more receptive to such measures. Systems governed by the Public Service Commission (PSC) must have its approval to change rates or rate schedules.

Although conservation pricing is important, it will not effectively reduce water use unless used in conjunction with an educational effort.

MEASURES THAT CAN BE USED ON ANY SYSTEM:

Seasonal rate - Higher rate during peak months. Effective when shortages and peak months coincide. Easy to administer. Must be adjusted so that rates are equitable per user.

Drought surcharge - Flat surcharge, regardless of use

Increasing block (progressive rate scale) - Higher rate charged per unit as total use increases. Rate rises in steps per block of volume

MEASURES THAT CAN BE USED ON METERED SYSTEMS:

Conservation discount - Discount for reducing use below required conservation level

Excess use charge - Higher rate for use above a fixed amount per billing period

Penalty charge (in conjunction with rationing)

Flat charge - for use above a certain amount (baseline), with an increase for subsequent offenses. Penalty charge should be high. The baseline maximum use figure can be one per capita (if population records are up to date); or two per household. Large volume users consider the latter to be equitable. Administering baseline maximum programs that vary per household is difficult.

Disconnect/reconnect charge - Charge for ceasing and/or reinstituting service after rationing provisions have been violated.

APPENDIX 10

ASSESSMENT AND RECOMMENDATIONS FOR DROUGHT PLANS

State and local drought contingency groups should be formed at the earliest possible time and should have statewide, regional, and local plans in place before the next drought occurs. However, before any type of definite plan is formulated, a concerted effort for public input is mandatory.

Public hearings to elicit input into the content of state and local drought plans are necessary, particularly in the drought-prone regions. These efforts should be coordinated by the State Drought Assessment Committee. Although it is difficult to convince people, even those at the highest level of state government or in the General Assembly that drought planning is necessary when there is no drought, it must still be done. The objectives of drought policy can be achieved only if they are formulated by all parties involved in the process, and by those affected. If done properly, the resulting plan will be successful. Questions which must be addressed include:

(1) What is the role of state government in drought preparedness, response, mitigation and recovery?

(2) What is the scope of the plan (i.e. agricultural, cultural, or multi-impact)?

(3) What are the most drought-prone areas of the state in relation to the areas of greatest need?

(4) What are the most vulnerable sectors of the state's economy and the most necessary?

(5) Will a plan provide assistance to resolve conflict between users during periods of shortage? How?

(6) What resources is the state willing to commit to the planning and mitigation? This would include, natural resources, human expertise, infrastructure, and capital.

(7) What legal, economic, political or social conditions affect water usage rates?

(8) What principal environmental concerns are associated with drought and how will the plan avoid or resolve conflicts between the environmental and economic sectors?

(9) *Will short-term emergency responses conflict with the ability to achieve long-term goals?* Other states have detailed drought plans in effect, and some states have hydrologic conditions which parallel Missouri's.

(10) What are the water use priorities? How will the water use priorities, as established in the Missouri Water Resources Law, be enforced? Who will carry out the necessary enforcement?

It is particularly important that drought emergency funding be sought at an early date to assure that monies are available

when the need arises. It should be recognized that the financial resources available to government change annually and from one administration to the next. This may provide an additional incentive for the state to formalize its drought plan through state statute, thus assuring that funds are available to carry out the program.

Another source of funding would be to temporarily "earmark" lottery funds to help defray the immediate costs of mitigating drought damages. This would require emergency legislation since lottery funds are mandated to support education. Necessary budget language should be developed now so that emergency uses of funds can take place without delay. It may be possible to setup a drought/flood emergency relief fund.

Care must be taken to ensure that a minimum amount of pre-drought planning takes place at the local level. At present there is very little incentive to commit limited financial resources toward drought mitigation planning.

There are, almost certainly, legal constraints which will affect the drought plan as it is formulated. These include

(a) methods available to control water use,

(b) the kinds of public trust laws in existence,

(c) requirements for contingency plans for water suppliers,

(d) emergency and other powers of the governor or state agencies during water shortages,

(e) interstate compacts, and

(f) water-quality standards.

It is imperative that any drought plan have some sort of evaluation process so that the plan can be updated or modified as needed. This evaluation should be an on-going process during droughts, and changes should be made as quickly as possible. However, prior to the advent of drought conditions and as a final step in the establishment of the plan, a detailed set of procedures needs to be adopted to ensure adequate evaluation of the plan. Two modes of evaluation must be in place:

(1) An ongoing or operational evaluation program that considers how changes such as new technology, legislative action, and changes in political leadership, may affect the operation of the plan;

(2) A post-drought assessment program that documents and critically analyzes the responseactions of government and others as appropriate, and that implements recommendations for improving the system.

To ensure an unbiased appraisal, nongovernmental organizations should be given responsibility for evaluating drought response efforts. The review team would address a prescribed set of questions regarding the response efforts. (See Appendix 6 for a sample set of evaluation questions.)

Missouri should encourage water conservation at all times, particularly in those areas where data indicates that drought is most prevalent. A drought in an area where the public is already used to conserving as a daily habit, will have less devastating effects. Tax incentives for water-conserving devices or appliances should be considered prior to the advent of drought conditions. These incentives or tax "breaks" for water conservation devices would be handled much the same as the energy conservation tax incentives are handled, except that the same "trigger mechanisms" used to require drought conservation would be used to start the tax incentives. The incentives would be prorated for the duration of the drought. Tax incentives should be considered in the "water-poor" areas of the state as an on-

going program, even in non-drought times. The incentives may be increased during drought conditions to offer further encouragement. Extending the tax incentives to include the installation of native drought-resistant plant species in new landscapes should also be considered.

Public education is very important and would be considerably easier during a drought, but this type of education needs to start prior to any drought. It needs to be a emphasized in the schools and in the media over an extended period of time to instill the idea of water conservation in the public mind. Throughout any drought alert or emergency the *Water Watch Report*, which was distributed during the last Missouri drought, should be revived. The report was very helpful to communities, planners, and state officials during the drought.

It may be possible to develop water-supply consortia along the lines of solid waste management districts. Members of the consortium would agree to share water with other members or sell water at a reasonable, prearranged cost during emergencies.

Another option would be for state agencies, such as the Department of Natural Resources (DNR), the Department of Conservation (MDC) or the Natural Resource Conservation Service (NRCS) to construct moderate-sized reservoirs that could be used most of the time for recreation, but would be available for water supply during droughts. Alternatively, the state agencies could share the cost of the reservoir with area towns that would be able to use the supply at a prearranged rate during drought. It may be necessary to amend existing legislation that addresses water resources and water supplies to enable these activities to take place during drought emergencies. Again, care would need to be taken to place recreation at a lower priority during drought conditions so that the water supplies in the reservoirs could be used.

APPENDIX 11

ALTERNATIVES

The following list of alternatives is aimed primarily at those areas which are most vulnerable to problems of prolonged drought. Priority ranking of the alternatives listed is difficult. They are a mix of institutional, scientific, technical, social, political, local, state and federal options. The listing is probably not complete. However, all of the alternatives are important and should be implemented prior to the advent of drought conditions.

(1) Plan and build new reservoirs in those areas remote from water sources or where groundwater supplies are deficient. Assess the potential for connecting to, or jointly building with, another water system.

(2) Assess available water volumes and enlarge existing reservoirs and clean mud and silt out of existing reservoirs to increase storage capacity.

(3) Gage streams and reservoirs to determine storage figures and find a "trigger point" to require conservation and rationing during a drought.

(4) If the water supply is a surface water stream intake, build a low-head dam to increase water storage at the intake and/or build off-channel storage.

(5) Conduct drilling programs to determine the groundwater storage capabilities of nearby stream alluvium.

(6) Construct "gallery wells" or horizontal, screened interceptors in the thin alluvium and conventional wells in the thicker alluvium.

(7) Determine "trigger points" using long-range weather predictions to start mandatory conservation measures.

(8) Plan now for the interconnection of public water districts that have supplies that are adequate for drought conditions. This alternative is not without inherent problems. The potential impact of additional water demand on a supply also under drought conditions must be carefully considered. Reliance upon one major source in a crisis could result in having multiple supplies on the verge of total outage.

(9) Immediately make detailed plans and set up the mechanisms for temporary (or permanent) pipelines to furnish water to water-short communities for both short-term and long-term shortages. In all cases, the water supply source should be identified well in advance of drought.

(10) Set up mechanisms for hauling water by truck and railroad to supply communities in desperate water-shortage conditions. Priority should be given to developing compacts with the states of Kansas and Iowa in this matter.

(11) Where conditions indicate that

it is geologically appropriate, deepen existing wells or pumps if water levels decline. If conditions permit drill new wells to alleviate shortages. Groundwater systems are the most difficult to predict safe yields for drought conditions. Deepening existing wells as a contingency for drought is the most difficult thing to convince well owners to do.

(12) Form a permanent drought committee as part of a detailed drought plan at the executive branch of state government. The committee should include agency directors to make and implement drought contingencies. The committee would be activated by the Governor and would be called the Drought Assessment Committee (DAC) (see Concept of Plan Operations for DAC duties).

(13) Make needed interstate water quality and quantity compacts with neighboring states, to establish definite interstate flows during drought periods.

(14) Establish "conservation rate structures" which are triggered at a predetermined Palmer index (or some other method determined by the state) to be applicable to the affected area. These rate structures would charge a user more if he used over a certain minimum rather than the cost being lower as more water is used (See Appendix 9, for details of pricing during drought events). This type of conservation would be locally mandated, but could be tied to the future availability of state grant monies. It has been suggested that it might be wise for some communities to have these rates in effect at all times to encourage conservation. The City of Wichita, Kansas, has had success with this strategy.

(15) Establish agreements such as Memorandums of Understanding (MOU) with commercial, private lake owners or government agencies having operational control of lakes that could serve as water-supply sources to furnish an agreed upon amount of water to nearby water supplies during drought emergencies. The means of transmitting set amounts of water would have to be determined at the time of agreement. Water quality would be one of the prime requirements for an agreement. Any such agreement should be underwritten with the conservation measures mentioned in alternative 14.

(16) Identify sites or locations for water loading stations for rural area water haulers.

(17) And perhaps the most important alternative is to *have a detailed drought plan to handle all phases of the drought as it occurs*. Drought planning is too often done after a drought has begun, making it reactionary rather than preventive. In most instances, there are very few options for mitigating drought damages once a drought is in progress.

(18) The long term alternative of water system regionalization either compliments or incorporates the previously listed alternatives 8, 9, and 16. Water system regionalization would serve to mitigate the impacts of drought through construction of regional supplies, distribution and storage facilities, management consolidation, water system consolidation, and water and wastewater district formation, along with water system regionalization is applicable for raw, treated freshwater systems and wastewater systems.

In October 1994, water system regionalization was identified as a priority that needs implementation in governmental units.

NOVEMBER 1994 - REGIONALIZATION SUPPORT STATEMENT

State and federal agencies should cooperatively encourage and place a high priority on funding projects directed at regionalization, and consider it a plus in the criteria for allocating grants and loans. Agencies should also support other entities actively developing regional systems. This should not preclude the eligibility of a system that requires an exemption or variance of the regionalization concept if a feasibility study certified by the agency indicates a regional system is not feasible.

Source: Regionalization Work Group, tasked by the Agriculture and Natural Resources Committee of Missouri Rural Opportunities Council. S.A. McIntosh, Chairman